

CLAIMS

That which is claimed is:

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AS
1. A laser apparatus comprising:
- (a) a gain medium having first and second output facets;
 - (b) a reflector, said reflector and said first output facet defining an external cavity;
 - (c) an optical output assembly optically coupled to said second output facet;
 - (d) a thermally conductive substrate, said gain medium and said optical output assembly mounted on said thermally conductive substrate,
 - (e) a thermoelectric controller joined to said thermally conductive substrate, said gain medium and said optical output assembly configured to be thermally controlled by said thermoelectric controller via thermal conduction through said substrate; and
 - (f) said reflector positioned remotely from said thermally conductive substrate and said thermoelectric controller.
2. The laser apparatus of claim 1, wherein said thermally conductive substrate has a coefficient of thermal expansion matched to that of said gain medium;
3. The laser apparatus of claim 1, further comprising:
- (a) a channel selector;
 - (b) a tuning assembly operatively coupled to said channel selector and configured to adjust said channel selector; and
 - (c) said channel selector and said tuning assembly positioned remotely from said substrate.
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4. The laser apparatus of claim 1, further comprising a first collimating lens optically coupled to said first output facet, said first collimating lens mounted on said thermally conductive substrate and configured to be thermally controlled by said thermoelectric controller by thermal conduction through said substrate.

5. The laser apparatus of claim 1, wherein said output assembly comprises a second collimating lens optically coupled to said second output facet.

6. The laser apparatus of claim 4, wherein said optical output assembly further comprises an optical isolator, said optical isolator optically coupled to said second collimating lens.

7. The laser apparatus of claim 4, wherein said optical output assembly further comprises a fiber focus lens; said fiber focus lens optically coupled to said optical isolator and to an optical fiber.

8. The laser apparatus of claim 1, further comprising a thermistor operatively coupled to said thermally conductive substrate and said thermoelectric controller.

9. The laser apparatus of claim 1, further comprising a grid etalon, said grid etalon mounted on said thermally conductive substrate.

10. The laser apparatus of claim 4, wherein said optical output assembly further comprises a coarse spectrometer; said coarse spectrometer mounted on said thermally conductive substrate.

11. The laser apparatus of claim 1, wherein said gain medium, said optical output assembly, said thermally conductive substrate and said thermoelectric controller are hermetically sealed in an inert atmosphere.

12. The laser apparatus of claim 1, wherein said thermally conductive substrate comprises a material selected from aluminum nitride, silicon carbide, and a silicon carbide/aluminum nitride alloy.

13. The external cavity laser apparatus of claim 3, wherein said reflector, said channel selector and said tuning assembly are mounted on a second, different substrate.

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14. An external cavity laser apparatus comprising:
- (a) a gain medium having first and second output facets, said gain medium emitting a first coherent beam from said first output facet along a first optical path and a second coherent beam from said second output facet along a second optical path;
 - (b) an end mirror positioned in said first optical path, said end mirror and said first output facet defining an external cavity;
 - (c) an optical output assembly positioned in said second optical path;
 - (d) a thermally conductive substrate, said gain medium and said optical output assembly mounted on said thermally conductive substrate;
 - (e) a thermoelectric controller joined to said thermally conductive substrate, said gain medium and said optical output assembly thermally coupled to said thermoelectric controller by said thermally conductive substrate; and
 - (f) said end mirror thermally isolated from said thermoelectric controller.

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15. The external cavity laser apparatus of claim 14, wherein said thermally conductive substrate has a coefficient of thermal expansion matched to that of said gain medium.

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16. The external cavity laser apparatus of claim 14, further comprising:
- (a) a channel selector positioned in said first optical path between said first output facet and said end mirror;
 - (b) a tuning assembly operatively coupled to said channel selector and configured to adjust said channel selector; and
 - (c) said channel selector and said tuning assembly thermally isolated from said thermally conductive substrate and said thermoelectric controller.
17. The external cavity laser apparatus of claim 16, wherein:
- (a) said channel selector comprises a wedge etalon; and
 - (b) said tuning assembly comprises a stepper motor configured to positionally adjust said wedge etalon in said first optical path.

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18. The external cavity laser of claim 17, wherein said tuning assembly further comprises an optical encoder configured to monitor positioning of said stepper motor and said wedge etalon.

19. The external cavity laser apparatus of claim 14, further comprising a first collimating lens positioned in said first optical path proximate to said first output facet, said first collimating lens mounted on said thermally conductive substrate and thermally coupled to said thermoelectric controller through said thermally conductive substrate.

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20. The external cavity laser apparatus of claim 14, wherein said optical output assembly comprises:

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- (a) a fiber focusing lens positioned in said second optical path and optically coupled to a fiber;
 - (b) a second collimating lens positioned in said second optical path between said second output facet and said fiber focusing lens; and
 - (c) an optical isolator positioned in said second optical path after said second collimating lens and before said fiber focusing lens.

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21. The external cavity laser apparatus of claim 20, further comprising a grid etalon mounted on said thermally conductive substrate and thermally coupled to said thermoelectric controller, said grid etalon positioned in said second optical path after said second collimating lens.

22. The external cavity laser apparatus of claim 20, further comprising a coarse spectrometer mounted on said thermally conductive substrate and thermally coupled to said thermoelectric controller, said coarse spectrometer positioned in said second optical path after said second collimating lens.

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23. An external cavity laser apparatus comprising:

- (a) a gain medium having first and second output facets, said gain medium emitting a first coherent beam from said first output facet along a first optical path and a second coherent beam from said second output facet along a second optical path;

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- (b) an end mirror positioned in said first optical path, said end mirror and said first output facet defining an external cavity;
 - (c) an optical output assembly positioned in said second optical path;
 - (d) a thermally conductive substrate, said gain medium and said optical output assembly mounted on said thermally conductive substrate;
 - (e) a thermoelectric controller joined to said thermally conductive substrate, said gain medium and said optical output assembly thermally coupled to said thermoelectric controller by said thermally conductive substrate; and
 - (f) said end mirror positioned to allow said thermoelectric controller to thermally control said gain medium and said optical output assembly independently from said end mirror.

24. The external cavity laser apparatus of claim 23, further comprising:

- (a) a channel selector positioned in said first optical path between said first output facet and said end mirror;
- (b) a tuning assembly operatively coupled to said channel selector and configured to adjust said channel selector; and
- (c) said channel selector and said tuning assembly positioned to allow said thermoelectric controller to thermally control said gain medium and said optical output assembly independently from said channel selector and said tuning assembly.

25. A laser apparatus comprising:

- (a) a gain medium having first and second output facets;
- (b) an end mirror optically coupled said first output facet;
- (c) an optical output assembly optically coupled to said second output facet;
- (d) a first substrate, said first substrate being thermally conductive, said gain medium and said optical output assembly mounted on said first substrate;
- (e) a thermoelectric controller joined to said first substrate, said gain medium and said optical output assembly configured to be thermally controlled by said thermoelectric controller via thermal conduction through said first substrate; and

- (f) a second substrate, said end mirror positioned on said second substrate and thermally isolated from said thermoelectric controller.

26. A laser apparatus, comprising:

- (a) a gain medium having first and second output facets;
- (b) an end mirror optically coupled to said first output facet;
- (d) a thermoelectric controller thermally coupled to said gain medium and configured to thermally control said gain medium independently from said end mirror.

27. The laser apparatus of claim 26, further comprising an optical output assembly optically coupled to said second output facet and thermally coupled to said thermoelectric controller, said thermoelectric controller configured to thermally control said optical output assembly.

28. A method of selectively cooling a laser apparatus comprising:

- (a) providing a gain medium having first and second output facets, an end mirror optically coupled to said first output facet, and an optical output assembly optically coupled to said second output facet; and
- (b) thermally controlling said gain medium and said optical output assembly independently from said end mirror.

29. The method of claim 28, wherein said thermally controlling comprises:

- (a) mounting said gain medium and said optical output assembly on a first, thermally conductive substrate, said first, thermally conductive substrate coupled to a thermoelectric controller; and
- (b) mounting said end mirror on a second substrate that is thermally isolated from said first substrate and said thermoelectric controller.

30. A laser apparatus, comprising:

- (a) a gain medium;

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- (b) a reflector, said reflector and an output facet of said gain medium defining a laser cavity; and
 - (c) means for providing selective thermal control to said gain medium independently from said reflector.

31. The laser apparatus of claim 30, further comprising:

- (a) an optical output assembly optically coupled to said gain medium; and
- (b) means for providing selective thermal control to said optical output assembly independently from said reflector.

32. The laser apparatus of claim 31, wherein said means for providing selective thermal control comprises:

- (a) a thermally conductive substrate, said gain medium and said optical output assembly mounted on said thermally conductive substrate,
- (e) a thermoelectric controller joined to said thermally conductive substrate, said gain medium and said optical output assembly configured to be thermally controlled by said thermoelectric controller via thermal conduction through said substrate.

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